SERVICE PIPES[1]

By F. N. Speller

Nearly every kind of pipe material has been used at some place or other for water service, cast iron, cast iron lined with enamel or glass, lead, zinc, galvanized wrought iron and steel, and wrought pipe with lead or cement lining. The report of the Committee on service pipe of the New England Water Works Association, September, 1916, contains some practical data on some of these varieties of pipe which are now in use, with particular reference to the value of certain protective coatings. In this brief paper I have thought it best to confine my remarks to certain developments in the manufacture and use of galvanized pipe for water service lines, recognizing the fact that there are other conditions where some more effective and more expensive protective coating, such as lead or cement lining, is required.

In discussing the deterioration of wrought pipe it will be convenient to consider (1) outside corrosion from soil, (2) internal corrosion from water. In each case it is important to know the relative durability of the unprotected metal by itself.

Wrought iron was the only form of iron which could be readily welded until about twenty-five years ago, when soft steel was developed to the point where it could be made into pipe. Since then this steel has been greatly improved and at present constitutes about 90 per cent of the wroughtpipe demand. It is important for the engineer and water works superintendent to form an accurate opinion on the relative durability and service ability of these two materials, which make up the cheapest and strongest pipe available at present. There has been so much discussion of an apparently contradictory character on this subject that one who has not given the complicated subject of corrosion some thought may easily be led to an erroneous conclusion. If opinions and hearsay evidence are eliminated and only comparative service under like conditions be admitted, it soon becomes clear that there is, in fact, very little dif-

[1] Read before the New York Section on February 21, 1917.

ference between wrought iron and steel as a class under most conditions, and the difference in opinion which has so long prevailed in the minds of honest observers may be satisfactorily explained. The extent of corrosion is found to depend on a number of external conditions, such as the quality of the water, temperature, and volume of flow, the presence of matter in suspension, contact of the pipe with other metals or the soil. Even the contact of dissimilar soils brought about in filling in the ditch will often be sufficient to set up electrolytic action and accelerate corrosion. This is a complicated matter and the relative influence of these factors cannot even be estimated, so that the only safe guide is to put both materials into service together and make a careful investigation of the results.

In considering outside corrosion, water works engineers may draw on the experience of gas companies. Some of these concerns have made a special study of this question during the past ten years and have put in both wrought iron and steel quite extensively for test purposes. A number of papers have been published in the *Proceedings of the American Gas Institute* giving detailed experience on wrought pipe under ground.* At this time, as a result of their experience and investigation, the majority of gas companies use steel pipe, some of which is protected with bituminous or combination bituminous and fabric coatings depending on conditions. Some public service companies have made a careful survey of soil conditions in their locality and have been able intelligently to apply coatings locally where conditions were found to warrant the additional expense.

A recent analysis of the pipe purchased by gas companies in 105 localities in New England showed the following, which is, I believe, representative of the present trend:

		per cent
Those using steel pipe exclusively,	75	71.42
Those using steel and wrought iron,	13	12.38
Those using wrought iron exclusively,	15	14.28
Unknown,	2	

Protection of the outside of pipe. Galvanizing has considerable value, but most gas service lines are coated with some form of bituminous coating. This over the galvanizing should be more effective. In unusually damp corrosive soil a layer or two of saturated fabric tightly wound on the pipe after the application of an impervious priming coat affords substantial protection.

* Proc. Am. Gas Inst.: Vol. 3—265, 274. Vol. 6, pt. 1—318, 348, 351, 357. Vol. 8, pt. 2—145, 154, 191, 212, 216, 223, 259. Vol. 9—1065.

In applying coal tar or asphalt to cold pipe the surface should first be dried and a priming coat applied, consisting of a thin mixture of coal tar or asphalt in benzol. When this has dried hot pitch may be applied, of a substantial thickness, which will adhere tightly to the cold metal. This should of course be done as near to the job as possible.

Internal corrosion. In the case of cold water services this depends primarily on the quality and flow of water. In some localities, where the water is slightly hard, no appreciable corrosion is found after twenty-five or thirty years, but in other localities, particularly when the water is soft and is saturated with oxygen and carbonic acid, the action is more rapid. However, in buildings, the experience with galvanized pipe (iron or steel) for cold water lines has been on the whole satisfactory, so that most architects now allow galvanized pipe on the cold water but require brass for the hot water line.

For this reason a test of the durability of pipe in cold water supply lines would take many years, and such tests should be made under a variety of water conditions. Many have taken advantage of the accelerated corrosion with heated water to compare various kinds of wrought iron and steel pipe in service, black and galvanized, so that there are now over one hundred and fifty such tests on record, all indicating that there is no fundamental difference in life between wrought iron and steel. There is no apparent reason why this experience does not apply to cold services using the same water.

Service tests of hot-water supply lines have recently been finished in the Pennsylvania Building, Philadelphia, in three of the New York City baths, and in the Irene Kaufmann Settlement, Pittsburgh, Pa. All were made under the supervision of independent investigators. A few typical pieces from the Irene Kaufmann Settlement are shown in Figures 1, 2 and 3, which are fairly representative of results obtained at the other places mentioned. The results of such service tests have never been questioned, even by wrought iron manufacturers, although the latter have offered the criticism that the contact of metals was unfavorable to the iron. This may or may not be the case, but even so, the influence of contact is to set up a very weak electromotive force which could extend only $\frac{1}{8}$ inch or so from the juncture. The extreme ends of the pipe always show more corro-

sion than parts farther in, due to this action or the erosion of eddy currents, and for this reason an inch or so of the ends are always discarded in measuring the corrosion. Another explanation as to

Average of 5 deepest pits, decimals of an inch,

0.121 0.128 0.121 0.111

Deepest pit, decimals of an inch,

0.126 0.131 0.127 0.117

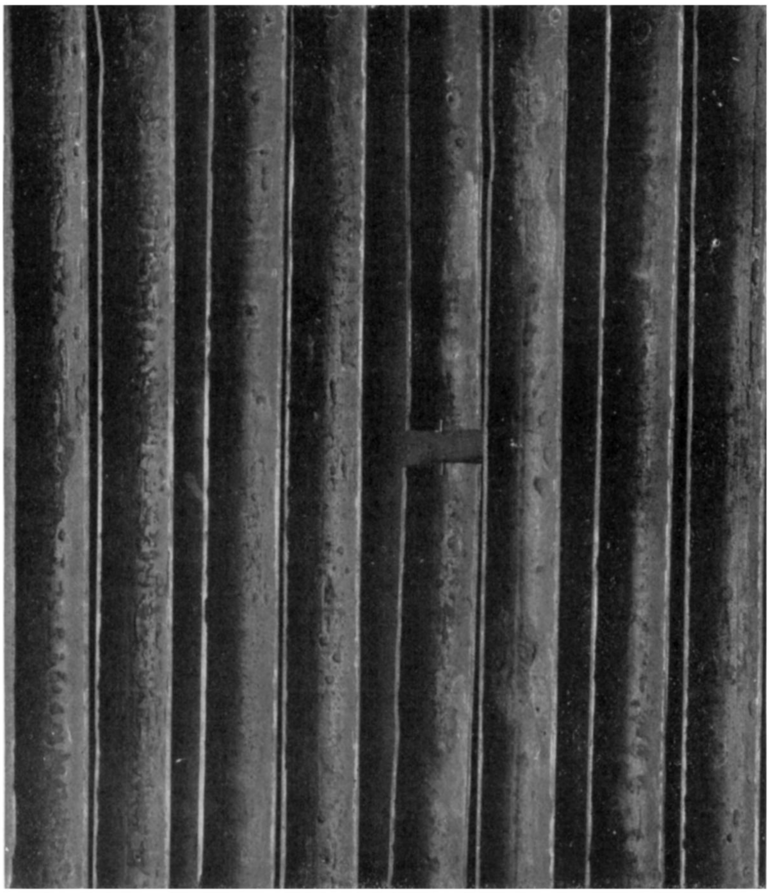


FIG. 1. CORROSION TESTS AT IRENE KAUFMANN SETTLEMENT
GENUINE WROUGHT IRON

why these tests have not borne out the expectations of some is that this particular iron was inferior. There are so many of such cases where the pipe was taken from commerical stocks that the average should be representative.

These tests of pipe carrying heated water also indicate that the galvanizing on wrought iron and steel pipe is practically the same in respect to its protective action on the metal. The zinc dis-

Average of 5 deepest pits, decimals of an inch,

0.123	0.123	0.107	0.110

Deepest pit, decimals of an inch,

0.127	0.125	0.120	0.124

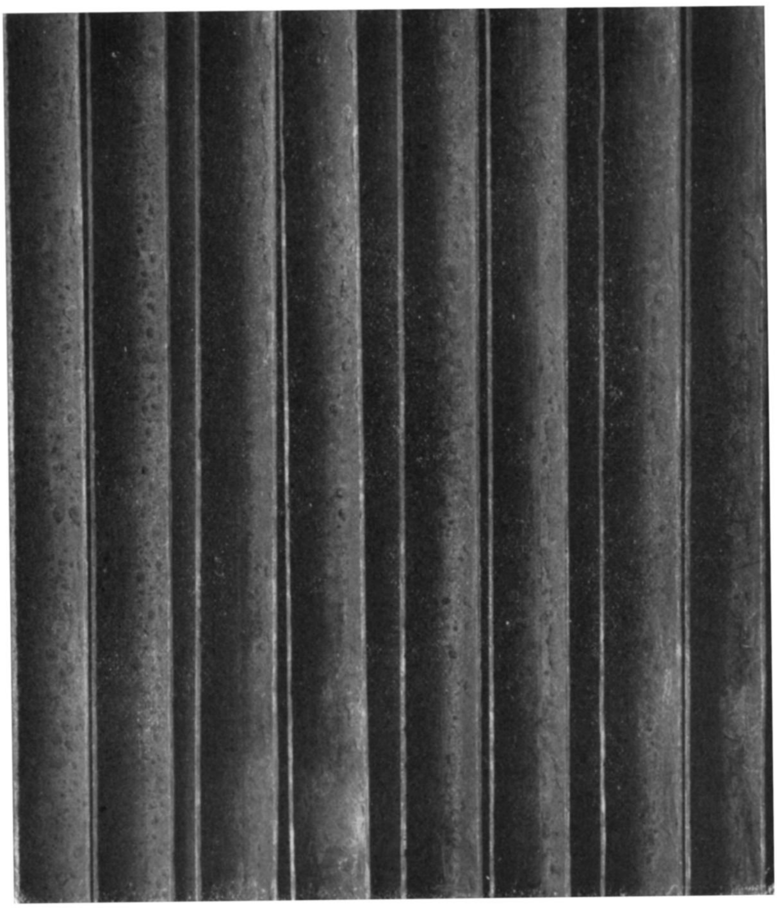


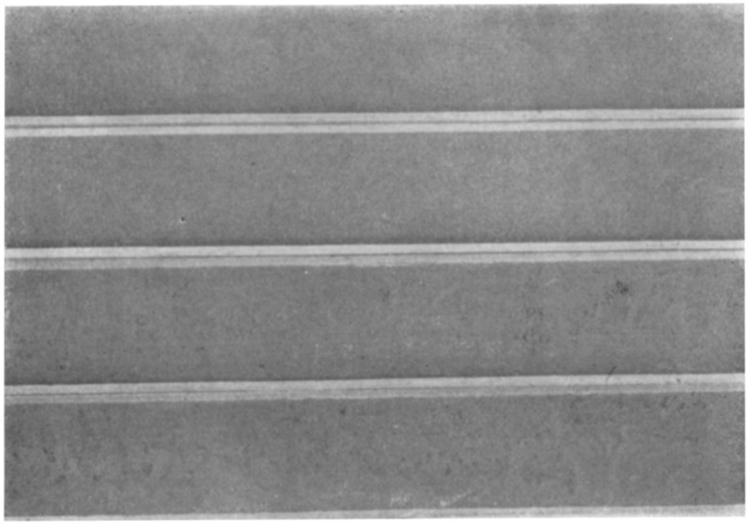
FIG. 2. CORROSION TESTS AT IRENE KAUFMANN SETTLEMENT
NATIONAL STEEL

solves rather rapidly leaving a zinc iron alloy which is alloyed with the iron.

As galvanized iron and steel are so generally used for services a word as to some practical features of galvanizing may be of in-

A

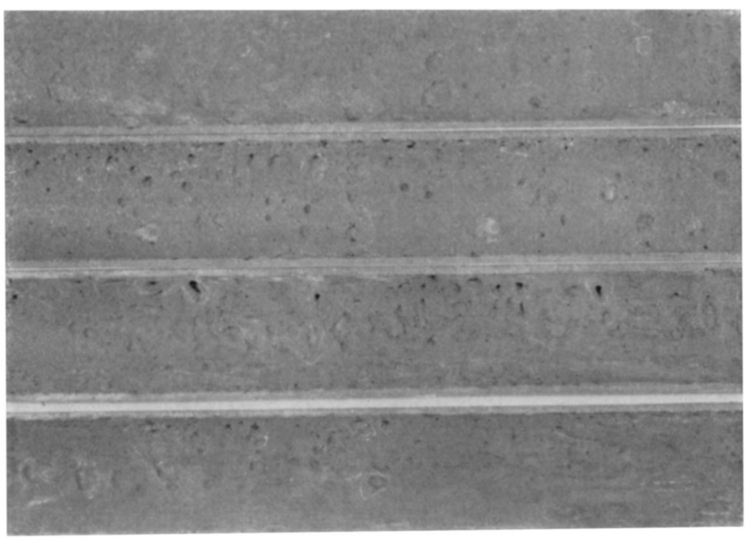
B



From deoxidizing system

C

D



From regular closed heating system

FIG. 3. COMPARISON OF PIPES OPERATING ON DEOXIDIZED AND NATURAL WATER

	A	B	C	D
Deepest pit, inch........................	0.019	0.047	0.127	0.126
Average of 3 deepest pits, inch...........	0.016	0.042	0.123	0.121

Note: Pieces A and C from same length of Steel pipe
Pieces B and D from same length of Wrought Iron pipe

terest. The most approved method as generally practiced by all pipe manufacturers in this country is known as the hot galvanizing process. The pipe is cleaned in acid, washed and neutralized in water, dipped in a fluxing bath and dried. It is then rolled into a bath of molten zinc which is maintained at a temperature of about 830°F., in which the pipe is allowed to remain until it acquires the temperature of the molten zinc. In the best practice no zinc is removed from the pipe, inside or outside, except what will naturally drain off when the pipe leaves the bath. Prime western spelter is generally used, averaging less than 1.5 % impurities. The weight of coating should average over 2 ounces per square foot of surface coated.

The uniformity of the coating depends on the cleaning of the surface in acid. This must not be carried too far or the metal will be "burned," so that the zinc will not alloy to the surface. Unfortunately the cinder formed in welding all pipe lies irregularly disposed on the interior surface and often carries siliceous matter picked up from the hearth of the furnace, which is like the enamel on cast iron in offering great resistance to the action of acid. The cleaning of the inside of buttweld pipe has been a very difficult problem, shared alike by all manufacturers of both wrought iron and steel pipe. A process for mechanically removing this scale from the hot pipe has recently been developed which promises to make possible considerable improvement in the zinc coating, and at the same time saves a large percentage of acid.

Zinc owes its protective power to its electro-positive character with respect to iron, i.e., a current is caused to flow from the zinc to the iron wherever the latter is exposed to water. No metallic coating so far made on a commercial scale is entirely free from pores or pin holes. Lead would be a better metal than zinc for this purpose except that any porosity in a lead coating leads to rapid destruction of the underlying iron, whereas zinc will protect iron an eighth of an inch or so away from the coating. Zinc forms an alloy with iron which possesses much less electro-positive power than pure zinc.

A Committee of the American Society of Testing Materials is now at work on specifications for galvanized coating. The unanimous opinion expressed with respect to the determination of the weight of zinc is that the lead acetate method for dissolving the coating is much preferable to the Preece or copper sulphate dip test.